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USSR: Declining Prospects for Three Major Oilfields

An Intelligence Assessment

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An Intelligence Assessment

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the Office of
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USSR: Declining Prospects for Three Major Oilfields

In response to the paucity of hard data on Soviet oil production, we have developed a way to use advanced techniques of geologic and reservoir engineering analysis to estimate current production and reserves at large Soviet oilfields and to project their future performance under likely alternative development scenarios. This paper presents the results—and implications—of our studies of three of the most important Soviet oilfields.

Key Judgments

We estimate that by 1985 the combined production of three of the largest oilfields in the Soviet Union—Romashkino, Arlan, and Samotlor—will decline by at least 1.3 million barrels per day (b/d). Unless the Soviets take extraordinary measures to boost production at these huge but aging fields, which currently account for more than one-third of total Soviet oil output, the decline could be as much as 1.9 million b/d. These measures would be very expensive and of uncertain effectiveness; moreover, in some cases the necessary equipment would have to come from Western firms.

The current Soviet Five-Year Plan calls for total national production of 12.4-12.9 million b/d by 1985, compared with an estimated 12.0 million b/d now. The projected declines in production from these three fields alone will require increases in production from other fields of at least 1.7 million b/d in order to meet the 1985 target. Production at other mature oilfields, however, is also declining. By 1985 the deficit could exceed 2 million b/d—or 100 million tons per year—an amount equivalent to the entire production of Mexico and more than current Soviet oil exports to Eastern Europe. Although the Soviets have good prospects of increasing output from a number of younger giant oilfields, it is unlikely that they could come up with this much extra oil from existing sources.

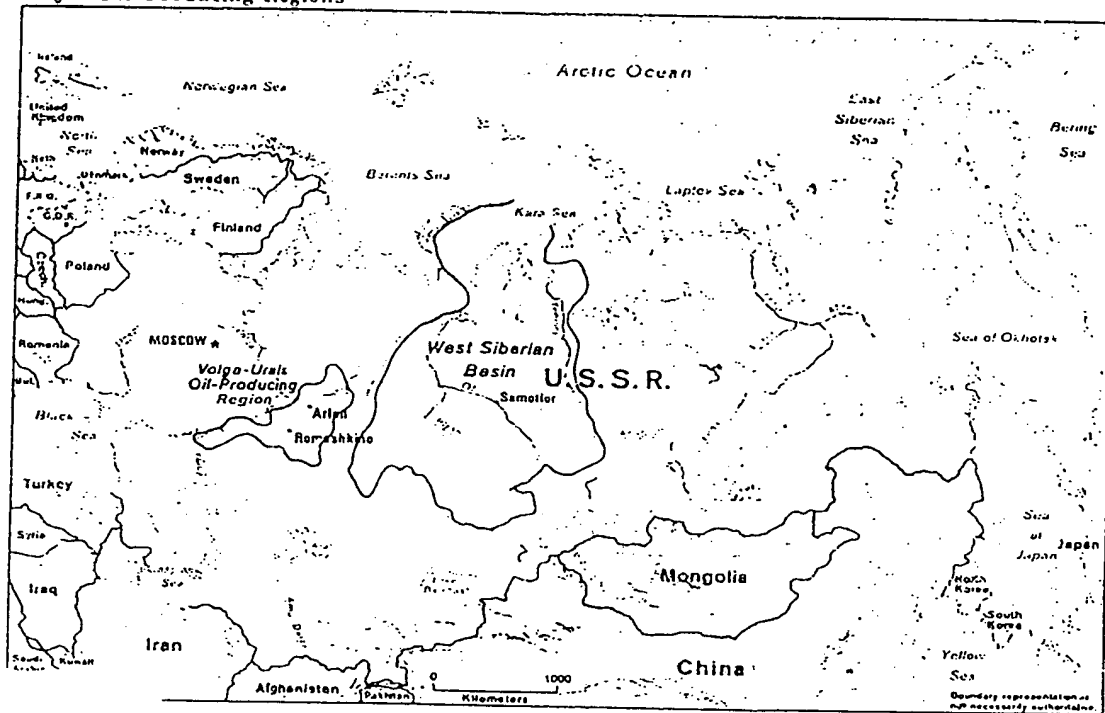
In the past, the Soviets have coped with prospective oil production shortfalls by developing new producing fields or areas. In recent years, however, they have concentrated their efforts on maximizing production at existing fields. Even if they began now, they would have great difficulty bringing enough new large fields onstream in time to avert a shortfall during the mid-1980s.

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Figure 1
Major Oil-Producing Regions



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USSR: Declining Prospects for Three Major Oilfields

For 30 years after World War II, oil production in the Soviet Union grew at enviable rates. During the mid-1970s the USSR became the world's leading oil producer. It now produces approximately 12 million barrels per day (b/d), or 600 million tons per year, of crude oil and natural gas condensate, about 20 percent more than Saudi Arabia and 18 percent more than the United States.

About five years ago, however, this rapid growth started to slow. Although the USSR remains very rich in petroleum resources, the Soviets are increasingly hard put to find and produce enough oil from new discoveries to replace that lost by the inevitable decline of older fields. If this trend continues, output could begin to drop within the next few years, and the Soviets could fall far short of their current Five-Year Plan target of producing 12.4-12.9 million b/d by 1985.¹

A Key Intelligence Question

Like most other major oil-producing countries, the Soviet Union depends on a small number of large giant and supergiant oilfields for most of its oil. Indeed, since the late 1940s the bulk of Soviet oil production has come from fewer than a dozen large oilfields, most of them located in two major oil regions: the Volga-Urals region, which was the mainstay of Soviet oil supplies from the 1950s through the mid-1970s, and the West Siberian basin, which has emerged over the past few years as the successor to the Volga-Urals region (figure 1). At many of these fields, however, reserves are declining and production is—or will soon begin—tapering off.

The ability of the Soviet Union to maintain self-sufficiency in oil supplies through the 1980s will depend heavily on the performance of a handful of such large, established fields. The Soviets need to keep output from these fields from deteriorating

drastically over the next few years in order to buy enough time to develop replacements or alternatives, such as increased supplies of coal and natural gas. Thus, determining the near-term prospects for such oilfields is a key intelligence question for the United States.

Our Approach

The Soviets have not published field-by-field production data for some time. Particularly since 1977—when the Soviets first became aware that CIA was trying to analyze their oil prospects—they have seldom reported production figures for major fields. The few figures they have made available have usually been conflicting or simply not credible. [

] To make matters worse, the Soviets have always treated data on their oil reserves as a state secret; consequently, we do not know what they believe their reserves to be—much less what those reserves might actually be.

To overcome this lack of information, we have developed a unique set of methodologies that permit us to estimate current production and reserves at major Soviet oilfields and to project the future yields of these fields according to likely alternative development scenarios. Our approach involves the application of advanced techniques of geologic and reservoir engineering analysis—techniques similar to those that a Western oil company might use to assess the prospects and plan the development of one of its own fields. Unlike the oil company, however, we lack physical access to the oilfields and must substitute information derived from [analysis for data the oil company can procure first-hand.]

The validity of this approach rests on the fact that the behavior of an oilfield and its reservoirs under recovery is governed by a strict set of fairly well understood physical laws. The reliability of our results, however,

¹ The most recent CIA estimate of the overall outlook for Soviet petroleum production is contained in NFAC Intelligence Assessment ER 81-10206 (Confidential), May 1981, *Soviet Oil Prospects*.

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can only be demonstrated by future events. At this point, we are very confident of the accuracy of the general trends our methodological approach reveals but somewhat less confident of the accuracy of our estimates of actual reserves and production.

The Results

We have applied this approach to three Soviet oil fields: Romashkino and Arlan, in the Voiga-Urals oil region, and Samotlor, in Western Siberia. At the time we chose these three fields as initial subjects for study, they were the three largest producing fields in the country. Moreover, they were representative of a larger group of fields with similar production problems.

Romashkino is a mature supergiant field that has dominated oil production in the Tatar ASSR since the early 1950s. Until 1972 it was the largest oilfield in the USSR in terms of both production and reserves, and it is still the country's second-largest producer. According to our calculations, there were close to 40 billion barrels of oil in place in its reservoirs when production began in 1952. Output peaked at 1.6 million b/d in 1970, a year in which Romashkino accounted for 27 percent of national production. In 1971 production from Romashkino began declining at a progressive rate that now stands at about 15 percent annually. We estimate current production at about 1.1 million b/d—still between 9 and 10 percent of total national output.

Our analysis indicates the Soviets will have extracted 11-11.5 billion barrels of oil from Romashkino's reservoirs by the end of 1981. If they continue their current secondary recovery operations—waterflooding—they should be able to extract another billion barrels by the end of 1985.² It is unlikely that the field will be yielding more than 500,000 b/d by then.

The Soviets have announced elaborate plans to enhance recovery from Romashkino through carbon-

dioxide (CO₂) injection.³ This technique, which elsewhere in the world has led to a recovery of an additional 5 to 13 percent of the original oil in place, offers more promise at Romashkino than alternative enhanced recovery methods. Nevertheless, we doubt the Soviets could reach even the low end of this range at Romashkino. The complex nature of the producing formations coupled with the destructive fashion in which Romashkino was initially developed would probably allow the Soviets to use CO₂ in no more than 10 of the 23 producing areas of the field. Moreover, to recover just 3 percent more of the original oil in place they would have to procure 10 times as much CO₂ as will apparently be available from chemical plants near Romashkino at Tol'yatti. Even assuming adequate supplies of CO₂ were available, it is unlikely that more than 1-1.5 billion additional barrels could be extracted this way—and it would take more than 20 years. Thus, CO₂ injection would yield a relatively modest return at very substantial cost. We do not know if the Soviets realize this, although there have been recent indications they are having second thoughts about the project.

Arlan is a large giant field in the Bashkir ASSR. Although its dwindling output and reserves are now smaller than those at a number of newer fields, until recently it was the third-leading oil producer in the Soviet Union. Placed in production in 1958, at its peak in 1974 it produced some 340,000 b/d, about 4 percent of national output. Production has decreased substantially since then, but is currently holding steady at about 160,000 b/d, a little more than 1 percent of total national output. Although dwarfed by Samotlor and Romashkino, Arlan merits serious study because its situation is characteristic of those at a growing number of older Soviet oilfields.

Unless the Soviets take extraordinary measures, Arlan will soon enter an advanced state of decline. Our analysis suggests the Soviets have already recovered about 20 percent of the estimated 7.5-8 billion barrels

² Waterflooding involves the injection of water under pressure into an oil reservoir to raise (or just maintain) its internal pressure and sweep the oil through pores in the rock toward the production wells. It is standard practice at most Soviet oilfields.

³ CO₂ injection (or flooding) can be used by itself or in conjunction with waterflooding to maintain pressure and sweep the oil in a reservoir toward the production wells. Unlike water, CO₂ mixes well with oil, forming a fluid that moves more easily through the pores in the rock.

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of oil originally in place in its diverse sandstone reservoirs. (Small amounts of oil have also been found in a series of carbonate reservoirs, but production from them appears to be insignificant.) If the Soviets pursue their current strategy of infill drilling (sinking new wells between the old wells) and waterflooding, the decline will resume, depressing output to about 110,000 b/d by 1985. Under such circumstances, ultimate recovery from the field will probably not exceed 2.1 billion barrels, about 27 percent of the original oil in place.

The Soviets might be able to reverse this decline temporarily, however, by using enhanced recovery techniques. The heterogeneity of the reservoirs at Arlan makes the field a poor candidate for most such techniques, but polymer flooding offers considerable promise.⁵ We have calculated that if polymer flooding were initiated at Arlan this year, it could conceivably increase output to a little more than 200,000 b/d by 1987 and lead, ultimately, to a recovery of as much as 34 percent of the original oil in place.

Polymer injection, however, has never been used on the scale that would be involved at Arlan, and its effectiveness when used on such a large scale in reservoirs with properties as diverse as those at Arlan is problematic. Moreover, the costs of initiating such a project at Arlan (indeed, anywhere) would be very high. And the Soviet chemical industry is not currently able to manufacture enough of the polymers needed to conduct a full-scale polymer flood at Arlan.⁶ Therefore, even though the Soviets have conducted some polymer flood experiments at Arlan, they may decide in the end that the payoff would be too small or too uncertain to justify the required investment.

Samotlor, a supergiant field in the Middle Ob region of Tyumen Oblast, was discovered in 1965 and put into production in 1969. With at least 50-55 billion

barrels of original oil in place, *Samotlor* is one of the largest oilfields in the world. During the early 1970s it outstripped Romashkino to become the largest producer in the Soviet Union. It now provides the USSR with 2.6-3.0 million b/d (130-150 million tons per year)—about 25 percent of total national oil output in 1981.

In keeping with standard Soviet practice, *Samotlor* has been developed intensively, with a view toward maximizing current production. About 4,500 production wells have been drilled to date, and further production drilling is scheduled to continue at least through 1985. At present, the Soviets are rounding out development of the field along its periphery and on its three large lakes. As usual, to maintain reservoir pressure and increase the flow of oil, the Soviets introduced waterflooding there very soon after regular production operations began. (In many cases they used cold, untreated water, which undoubtedly damaged the reservoirs.) Most of the wells at *Samotlor* are still free flowing, meaning the oil is forced out of the ground by internal pressure alone; an increasing number, however, are being produced by means of walking-beam (sucker-rod) and submersible pumps, and a few wells have been put on gas lift.

Despite its relative youth, *Samotlor* is already experiencing some problems of the sort usually associated with declining oilfields. For example, our analysis suggests that watercuts are rising fast, forcing the Soviets to withdraw steadily increasing amounts of fluid in order to extract a constant amount of oil.⁷ Although the watercuts in the newer, northern part of the field are still very low, they may average as much as 50 percent among the older wells in the southern portion, and 30 percent in the field as a whole. To counter this problem, the Soviets would be expected to intensify infill drilling, increase the proportion of wells on pump or under gas lift, and speed up development of areas around the edge of the field—even though current drilling in these areas is yielding wells less productive than those in the older areas of the field. Indeed, they are trying to take all of these actions.

⁵ Gas can be injected into a producing well to drive the oil up the well bore.

⁷ The watercut is the proportion of water in the mixture of water, oil, and liquefied gas extracted from a production well.

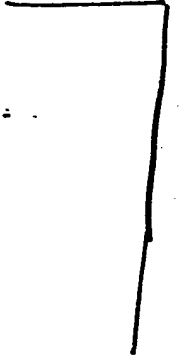
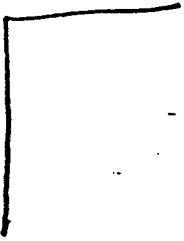
⁶ This would be relatively poor performance in a US oilfield, where primary and secondary recovery methods are usually expected to extract at least 35 to 40 percent of the original oil in place.

⁷ Polymer flooding involves the injection into a reservoir under waterflood of a solution of specially designed chemicals—either polysaccharides or polyacrylamides—to improve the ability of the waterflood to sweep the oil toward the production wells. It is especially effective in reservoirs containing heavy, or viscous, oil.

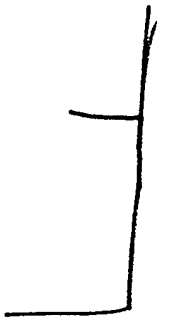
⁸ The Soviets have recently been seeking polymer supplies from foreign sources, but they have not indicated these chemicals would be used at Arlan.

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To accomplish them, however, the Soviets will need to acquire large numbers of high-capacity submersible pumps, large-volume hydraulic pumps, and compressor-driven gas-lift equipment. Some of this equipment can be supplied in adequate quantities only by Western manufacturers—whose production schedules may not meet Soviet needs. The Soviets had intended, for example, to begin converting the whole field to gas lift in 1981, but delays in constructing compressor stations and in receiving gas-lift equipment purchased from France will postpone this for at least another year.

Because they have no way at present of replacing its enormous output, Samotlor's ability to keep producing at high rates is of critical importance to the Soviets. Consequently, we have subjected this field to full-scale engineering analysis on three occasions—in 1978, in 1980, and again in 1981. Although we now understand this oilfield rather well, because of a lack of recent production data some key uncertainties remain. We do not know, for one thing, exactly when production at Samotlor peaked (although we are fairly certain it has peaked), and we do not know precisely what the peak production was.

We estimate, however, that Samotlor probably reached its peak output between 1978 and 1980 at a level no higher than 3.0 million b/d—below the 3.2 million b/d the Soviets had hoped (and planned) to reach. According to the best data now available to us, production currently stands at somewhere between 2.6-3.0 million b/d. Depending on when the peak actually occurred, the Soviets might be able to maintain this rate for one or two more years if enough large-volume artificial lift equipment is available. Thereafter, the field should begin to decline quite rapidly, at an initial annual rate of perhaps 10 to 15 percent. (The longer the Soviets manage to defer this decline, the more precipitous it will be.) By 1985, we calculate, production will probably have dropped to between 1.6-2.2 million b/d.

* If output from Samotlor does begin to decline soon at the rates our engineering analysis leads us to predict, we cannot rule out the possibility that the Soviets would take heroic measures to counteract this trend. Apart from its singular contribution to current Soviet petroleum supplies, the field is the showpiece of the Soviet oil industry and a bulwark of national morale. For these reasons the Soviets might feel compelled to pull out all stops to postpone the inevitable decline. Conceivably, such extraordinary efforts might

Implications

If the situations at Romashkino, Arlan, and Samotlor develop as we have outlined, the combined production from these fields will drop 1.3-1.9 million b/d by 1985. This is the range that results from totaling our high and low projections of the performances of the three oilfields under various likely production scenarios. We expect actual performances to fall somewhere between these extremes.

The current Soviet Five-Year Plan calls for national oil production to reach 12.4-12.9 million b/d by 1985. Thus, even under very optimistic production scenarios at all three oilfields, the Soviets will need to obtain at least an additional 1.7 million b/d from other sources to meet the goal of the plan. Although they have good prospects of increasing production from a number of younger giant oilfields in Western Siberia and the Caspian basin, it currently appears unlikely that they can come up with this much from these sources alone.

Moreover, the total shortfall that the Soviets will have to make up is likely to be considerably greater than 1.7 million b/d. Production from other aging large fields will also be declining. Furthermore, holding the decrease at Romashkino, Arlan, and Samotlor to 1.3 million b/d will be exceedingly difficult and expensive—and will require cooperation from Western firms and governments, as well as considerable luck. A total decrease exceeding 2 million b/d—or 100 million tons per year—is not unlikely. That is more oil than Romashkino ever produced in one year and possibly more than Samotlor will be producing in 1985. In other words, the Soviets will have to find new oil supplies to cover a deficit roughly equivalent to the entire production of Mexico—which is more oil than they currently export to Eastern Europe.

Traditionally, the Soviets have coped with declining oil production from established fields by developing new producing fields and areas. There are enormous

maintain production at near the current levels over the next five years, although we judge this unlikely. Furthermore, the Soviets already appear to be pouring men and material into Samotlor about as fast as they can be found. Any substantial increase in the resources devoted to the field would have to come at the expense of decreasing investment at other fields in Western Siberia, many of which are already yielding relatively better returns than Samotlor.

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untapped deposits of oil in the eastern regions of the country—some of which the Soviets may already have discovered—but it seems unlikely this time that any near-term relief will be coming from this quarter. Typically, it takes at least five to seven years to bring a large new oilfield onstream. As yet, however, the Soviets have made no concerted efforts to develop any major new areas, probably because the manifold risks and difficulties involved have made it seem preferable for the present to devote most of their available investment capital, equipment, and technical personnel to maximizing output at oilfields like Romashkino, Arlan, and Samotlor. By 1985 this may prove to have been a shortsighted and costly decision.

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